2.0 Graphical FIS Products

This section deals with a variety of FIS products, collectively referred to as graphical. The presentation method may include the display of symbols, contours or outlines, or images representing activity such as precipitation.

2.1 NEXRAD Precipitation Graphic Products -Background

NEXRAD precipitation graphic products are transmitted in image format without a base map. Optionally they may be compressed using an appropriate scheme identified in Section D.2.2 in RTCA DO-267A. They contain data and annotation pixels. Three types of image encoding schemes, as defined below, are used to represent radar intensities and annotations. Encoding schemes for NEXRAD Precipitation Image Products are described in the following paragraphs. The NEXRAD precipitation graphics are geographically referenced using a method described in Section D.2.3 in RTCA DO-267A. There are two types of annotations that may be included in a graphic: site status indicators (for National and Regional products) and missing severe weather boxes. These annotations have meaning only for mosaic products, not individual NEXRAD site products.

2.1.1 Site status indicators (optional)

In addition to radar data, NEXRAD images may contain information about the status of each radar site. There are currently two status indicators that are used: 'present' and 'absent.' A site that is 'present' may be denoted in the image by a single pixel near the site's location with a special code. A site that is 'absent' may be denoted in the image by a single pixel near the site's location with a different code. It will be up to the end user's software to place a warning marker or 'ok' symbol to indicate the status of the radar site.

2.1.2 Missing severe weather box (optional)

An indicator of an area of missing severe weather may be included in the image. This area is known as a 'warning box.' It suggests that there are echoes of significant intensity missing from the image. The location of the missing echoes may be indicated with a 2-color box. The border of the box (codes 8-15) will be transmitted as 1 pixel in width, although it may be displayed with different thickness. The interior of the box (code 32) replaces all other NEXRAD pixel data.

2.2 Type 0 NEXRAD Precipitation Image Graphic encoding Scheme (4-level)

Assigned Product ID #s as follows:

51 for National Mosaic

55 for Regional Mosaic

59 for Individual NEXRAD Site

In this scheme, data values are represented by the codes in Table 2.2-1.

Table 2.2-1 Type 0 NEXRAD Encoding

Code	Represents		Hex
0	radar data level 0	dBZ <20, No data	0x00
1	radar data level 1	20 ≤ dBZ < 30	0x01
2	radar data level 2	30 ≤ dBZ < 40	0x02
3	radar data level 3	40 ≤ dBZ	0x03

Note: No codes are used to indicate missing data from a NEXRAD site. In this scheme, a header containing codes indicating locations for missing stations precedes the file.

2.3 Type 1 NEXRAD Precipitation Image Graphic Encoding Scheme (8-level)

Assigned Product ID #s as follows:

52 for National Mosaic

56 for Regional Mosaic

60 for Individual NEXRAD Site

In this scheme, data values are represented by the codes in Table 2.3-1. Note that these codes are compatible with legacy systems using the NWS video integrated processor (VIP) levels (air traffic control weather radar levels). They deviate slightly from A/C 25-11 or A/C 23.13-11, which define level 1 as 20 dBZ and each subsequent level in 10-dB increments. Deviations from these standards are more conservative than the above-referenced standards (with exception of a 1 dB-variation in level 3), so they should be acceptable.

Note: For color encoding, see Table 3-2, Section 3.8.2 in RTCA DO-267A.267A267A

Table 2.3-1 Type 1 NEXRAD Encoding

Code	Represents		Hex	Optional or Not
0	radar data level 0	dBZ < 5, No data	0x00	
1	radar data level 1	5 ≤ dBZ < 18	0x01	
2	radar data level 2	18 ≤ dBZ < 30	0x02	
3	radar data level 3	30 ≤ dBZ < 41	0x03	
4	radar data level 4	41 ≤ dBZ < 46	0x04	
5	radar data level 5	46 ≤ dBZ < 50	0x05	
6	radar data level 6	50 ≤ dBZ < 57	0x06	
7	radar data level 7	57 ≤ dBZ	0x07	
8	warning box border over level 0		0x08	Optional
9	warning box border over level 1		0x09	Optional
10	warning box border over level 2		0x0A	Optional
11	warning box border over level 3		0x0B	Optional
12	warning box border over level 4		0x0C	Optional
13	warning box border over level 5		0x0D	Optional
14	warning box border over level 6		0x0E	Optional
15	warning box border over level 7		0x0F	Optional
16	present site indicator over level 0		0x10	Optional
17	present site indicator over level 1		0x11	Optional
18	present site indicator over level 2		0x12	Optional
19	present site indicator over level 3		0x13	Optional
20	present site indicator over level 4		0x14	Optional
21	present site indicator over level 5		0x15	Optional
22	present site indicator over level 6		0x16	Optional
23	present site indicator over level 7		0x17	Optional
24	absent site indicator over level 0		0x18	
25	absent site indicator over level 1		0x19	
26	absent site indicator over level 2		0x1A	
27	absent site indicator over level 3		0x1B	
28	absent site indicator over level 4		0x1C	
29	absent site indicator over level 5		0x1D	
30	absent site indicator over level 6		0x1E	
31	absent site indicator over level 7		0x1F	
32	warning box inside over level 0		0x20	Optional

2..4 Type 2 NEXRAD Precipitation Image Graphic Encoding Scheme (8-level)

Assigned Product ID #s as follows:

53 for National Mosaic

57 for Regional Mosaic

61 for Individual NEXRAD Site

In this scheme, data values are represented by the codes in Table 2.4-1. This type 8-level NEXRAD product is an abbreviated version of the standard 16-level product described in the next paragraph.

Note: For color encoding, see Table 3-2, Section 3.8.2 in RTCA DO-267A.

Table 2.4-1 Type 2 NEXRAD Encoding

Code	Represents		Hex	Optional or Not
0	radar data level 0	dBZ < 20, No data	0x00	
1	radar data level 1	20 ≤ dBZ < 25	0x01	
2	radar data level 2	25 ≤ dBZ < 30	0x02	
3	radar data level 3	30 ≤ dBZ < 35	0x03	
4	radar data level 4	35 ≤ dBZ < 40	0x04	
5	radar data level 5	40 ≤ dBZ < 50	0x05	
6	radar data level 6	50 ≤ dBZ < 60	0x06	
7	radar data level 7	60 ≤ dBZ	0x07	
8	warning box border over level 0		0x08	Optional
9	warning box border over level 1		0x09	Optional
10	warning box border over level 2		0x0A	Optional
11	warning box border over level 3		0x0B	Optional
12	warning box border over level 4		0x0C	Optional
13	warning box border over level 5		0x0D	Optional
14	warning box border over level 6		0x0E	Optional
15	warning box border over level 7		0x0F	Optional
16	present site indicator over level 0		0x10	Optional
17	present site indicator over level 1		0x11	Optional
18	present site indicator over level 2		0x12	Optional
19	present site indicator over level 3		0x13	Optional
20	present site indicator over level 4		0x14	Optional
21	present site indicator over level 5		0x15	Optional
22	present site indicator over level 6		0x16	Optional
23	present site indicator over level 7		0x17	Optional
24	absent site indicator over level 0		0x18	
25	absent site indicator over level 1		0x19	
26	absent site indicator over level 2		0x1A	
27	absent site indicator over level 3		0x1B	
28	absent site indicator over level 4		0x1C	
29	absent site indicator over level 5		0x1D	
30	absent site indicator over level 6		0x1E	
31	absent site indicator over level 7		0x1F	
32	Warning box inside over level 0		0x20	Optional

2.5 Type 3 NEXRAD Precipitation Image Graphic Encoding Scheme (16-level)

Assigned Product ID #s as follows:

54 for National Mosaic

58 for Regional Mosaic

62 for Individual NEXRAD Site

This is the standard 16-level NEXRAD precipitation image. In this scheme, data values are represented by the codes in Table 2.5-1.

Note: For color encoding, see Table 3-2, Section 3.8.2 in RTCA DO-267A.

Table 2.5-1 Type 3 NEXRAD Encoding

Code	Represents		Hex	Optional or Not
0	Radar data level 0	dBZ < 5, No data	0x00	
1	Radar data level 1	5 ≤ dBZ < 10	0x01	
2	Radar data level 2	10 ≤ dBZ < 15	0x02	
3	Radar data level 3	15 ≤ dBZ < 20	0x03	
4	Radar data level 4	20 ≤ dBZ < 25	0x04	
5	Radar data level 5	25 ≤ dBZ < 30	0x05	
6	Radar data level 6	30 ≤ dBZ < 35	0x06	
7	Radar data level 7	35 ≤ dBZ < 40	0x07	
8	Radar data level 8	40 ≤ dBZ < 45	0x08	
9	Radar data level 9	45 ≤ dBZ < 50	0x09	
10	Radar data level 10	50 ≤ dBZ < 55	0x0A	
11	Radar data level 11	55 ≤ dBZ < 60	0x0B	
12	Radar data level 12	60 ≤ dBZ < 65	0x0C	
13	Radar data level 13	65 ≤ dBZ < 70	0x0D	
14	Radar data level 14	70 ≤ dBZ < 75	0x0E	
15	Radar data level 15	75 ≤ dBZ	0x0F	
16	present site indicator over level 0		0x10	Optional
17	present site indicator over level 1		0x11	Optional
18	present site indicator over level 2		0x12	Optional
19	present site indicator over level 3		0x13	Optional
20	present site indicator over level 4		0x14	Optional
21	present site indicator over level 5		0x15	Optional
22	present site indicator over level 6		0x16	Optional
23	present site indicator over level 7		0x17	Optional
24	present site indicator over level 8		0x18	Optional
25	present site indicator over level 9		0x19	Optional
26	present site indicator over level 10		0x1A	Optional
27	present site indicator over level 11		0x1B	Optional
28	present site indicator over level 12		0x1C	Optional
29	present site indicator over level 13		0x1D	Optional
30	present site indicator over level 14		0x1E	Optional
31	present site indicator over level 15		0x1F	Optional
32	absent site indicator over level 0		0x20	
33	absent site indicator over level 1		0x21	
34	absent site indicator over level 2		0x22	
35	absent site indicator over level 3		0x23	
36	absent site indicator over level 4		0x24	
37	absent site indicator over level 5		0x25	
38	absent site indicator over level 6		0x26	

Code	Represents	Hex	Optional or Not
39	absent site indicator over level 7	0x27	
40	absent site indicator over level 8	0x28	
41	absent site indicator over level 9	0x29	
42	absent site indicator over level 10	0x2A	
43	absent site indicator over level 11	0x2B	
44	absent site indicator over level 12	0x2C	
45	absent site indicator over level 13	0x2D	
46	absent site indicator over level 14	0x2E	
47	absent site indicator over level 15	0x2F	
48	warning box border over level 0	0x30	Optional
49	warning box border over level 1	0x31	Optional
50	warning box border over level 2	0x32	Optional
51	warning box border over level 3	0x33	Optional
52	warning box border over level 4	0x34	Optional
53	warning box border over level 5	0x35	Optional
54	warning box border over level 6	0x36	Optional
55	warning box border over level 7	0x37	Optional
56	warning box border over level 8	0x38	Optional
57	warning box border over level 9	0x39	Optional
58	warning box border over level 10	0x3A	Optional
59	warning box border over level 11	0x3B	Optional
60	warning box border over level 12	0x3C	Optional
61	warning box border over level 13	0x3D	Optional
62	warning box border over level 14	0x3E	Optional
63	warning box border over level 15	0x3F	Optional
64	warning box inside over level 0	0x40	Optional

2.6 Radar Echo Top Graphics - Background

Radar echo top graphics are transmitted in either bitmap or image format with optional accompanying information in numerical format. They are transmitted without a base map. Optionally, the images may be compressed using an appropriate scheme identified in Section D.2.2 in RTCA DO-267A. Echo Top bitmap products are generated using an encoding scheme defined in the following Sections 2.7 and 2.8. These products generated contain image data values that represent echo tops in thousands of feet. Storm top and velocity products may also be generated using an encoding scheme defined in following Section 2.9.

Echo top bitmap products are similar to NEXRAD precipitation graphics. They contain data values that indicate echo tops only. Echo top graphics can be regional or national. They may be geographically referenced using a method described in Section D.2.3 in RTCA DO-267A. Accompanying numerical information is geographically referenced using Latitude/longitude.

Optional accompanying numerical information may be included with image format products. Numerical information includes fields indicating the latitude and longitude of the area in which the top of storm was measured, the ground speed of the storm and its heading (relative to true north). The format of the numerical information is defined below in Section 2.9.

The following assumptions are associated with this product:

- Range of echo top may be up to 100,000 ft (outside of Continental United States [CONUS])
- Range of echo top may be up to 60,000 ft (within CONUS)
- Resolution/depiction of echo top no better than 0.6 NM, or 0.01 degree.
- Projection of echo top onto underlying map will be more efficient if latitude and longitude are reported in fractions of degrees rather than in degrees, tenths of minutes (Variance from DO-

219).

2.7 Echo Top Image Graphics Scheme 1 (16-level)

Assigned Product ID # 81.

In this scheme, bitmapped data values are represented by the codes in Table 2.7-1.

Table 2.7-1 Echo Top Image Graphics Scheme 1

Code	Represents	Hex
0	no echoes	0x00
1	5 kft above mean sea level	0x01
2	10 kft above mean sea level	0x02
3	15 kft above mean sea level	0x03
4	20 kft above mean sea level	0x04
5	25 kft above mean sea level	0x05
6	30 kft above mean sea level	0x06
7	35 kft above mean sea level	0x07
8	40 kft above mean sea level	0x08
9	45 kft above mean sea level	0x09
10	50 kft above mean sea level	0x0A
11	55 kft above mean sea level	0x0B
12	60 kft above mean sea level	0x0C
13	65 kft above mean sea level	0x0D
14	70 kft above mean sea level	0x0E
15	region of missing data	0x0F

2.8 Echo Top Image Graphics Scheme 2 (8-level)

Assigned Product ID # 82.

In this scheme, bitmapped data values are represented by the codes in Table 2.8-1.

Table 2.8-1 Echo Top Image Graphics Scheme 2

Code	Represents	Hex
0	No echoes	0x00
1	5 kft above mean sea level	0x01
2	10 kft above mean sea level	0x02
3	15 kft above mean sea level	0x03
4	20 kft above mean sea level	0x04
5	25 kft above mean sea level	0x05
6	$\geq$ 30 kft above mean sea level	0x06
7	region of missing data	0x07

2.9 Storm Tops and Velocity (numerical)

Assigned Product ID # 83.

Numerical fields indicating the latitude and longitude of the area in which the top of storm was measured, the ground speed of the storm and its heading (relative to true north), may optionally be included. They have the format as shown in Table 2.9-1.

Table 2.9-1 ASN.1 Representations of Storm Tops

```
Echo_tops_data::= SEQUENCE SIZE(1..32) OF Top_data

Top_data::= SEQUENCE
{
Top5000_or_missing,
Lat_long_hundredths,
StormSpeedOPTIONAL,
DegreesTrue          OPTIONAL,
}

     top5000_or_missing ::= INTEGER(1..15)
     --Altitude in 5000's of feet
     --Units = 5000 Feet, Range (01..15)
     --value of 15 implies boundary of region of missing data

Lat_long_hundredths::= SEQUENCE
-- Latitude/Longitude in degrees/hundredths of degrees
{Latitude_hundredths,
Longitude_hundredths}
Latitude_hundredths::=INTEGER(-9000 .. 9000)
-- Latitude in degrees/hundredths of degrees

Longitude_hundredths::=INTEGER(-18000 .. +18000)
--Longitude in degrees/hundredths of degrees

     StormSpeed ::= INTEGER(0 .. 63)
     -- Ground speed of storm in knots

Degreestrue ::= INTEGER(1 .. 360)
Heading in degrees relative to true North
```

2.10 Type 4 NEXRAD Precipitation Image – Global Block Representation

Assigned Product ID # 63.

2.10.1 Definition

This description provides the format for encoding NEXRAD graphic products using the Global Block Representation format described in Section D.2.3.5 of RTCA DO-267A (FIS-B MASPS).

2.10.2 Assumptions

The receiving system can assume that when this product is received from multiple ground stations offering overlapping coverage, the areas of overlap will be assured to register and can be simply merged on the cockpit display. Each broadcasting ground station will typically broadcast product covering a 250 NM radius of the broadcasting ground station.

2.10.3 APDU Format

2.10.3.1 APDU Header

The format of the APDU header used for this product is shown in the Figure below. It follows the APDU Header Format as outlined in Appendix D of RTCA DO-267A with none of the optional fields used for this product; specifically, no Product Descriptor options and no APDU segmentation are used.

The last four zeros show the pad that is required to round out the APDU header to end on a byte boundary. The time field encoded in the APDU header is the time of product creation.

← APDU Header (48 bits) →																																			
FIS-B APDU ID (16 bits)	Product Descriptor (14 bits)																																		
	A f	G f	P F	Product ID (11 bits)																																
(See Note 1)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0													0	0	0	0		

	S f	Header Time (13 bits)																																	
		T opt	Hours (5 bits) *(See Note 3)*																																
			Minutes (6 bits) *(See Note 3)*																																
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Pad (4 bits)				
0	0	0	0	

Transmission order →

Notes:

1) The FIS-B APDU-ID is not transmitted in the FAA (FIS-B) network

2) While this product employs the minimal APDU header format shown above, avionics designed for operation on the FAA's network should not preclude the ability to parse ADPUs with any of the optional fields invoked. This will ensure any future products that may employ these optional fields can be processed.

3) The Hours and Minutes fields each have the MSB as the leftmost bit and the LSB as the rightmost bit.

2.10.3.2 Payload

The Global Block Representation geo references individual "bins" of the NEXRAD image to latitude and longitude rather than on a projection requiring a point of tangency. The encoded intensity levels for the individual "bins" map into "dBz" reflectivity levels as shown in the table below.

Intensity Encoding of NEXRAD Composite Reflectivity Product

Intensity Encoded Value	dBz Reflectivity Range	Weather Condition
0	dBz < 5	
1	5 ≤ dBz < 20	
2	20 ≤ dBz < 30	VIP 1
3	30 ≤ dBz < 40	VIP 2
4	40 ≤ dBz < 45	VIP 3
5	45 ≤ dBz < 50	VIP 4
6	50 ≤ dBz < 55	VIP 5
7	55 ≤dBz	VIP 6

Notes:

1) *The color rendering on cockpit displays of the Intensity Encoded Values 2(two) through 7 (seven) should follow the Color Philosophy for the associated Weather Condition as described in Section 3.8.2 (Table 3-2) of RTCA DO-267A (FIS-B MASPS).*
2) *The Intensity Encoded Values 0 (zero) and 1 (one) are considered Background and should be color rendered accordingly.*

2.11 Lightning Strike Graphics - Background

Lightning strike graphics are transmitted in image format without a base map. Optionally they may be compressed using an appropriate scheme identified in Section D.2.2 in RTCA DO-267A. Three image-encoding schemes are used to represent lightning strikes, as described in the following paragraphs. These lightning strike image graphics are geographically referenced using a method described in Section D.2.3 in RTCA DO-267A. Location of lightning strikes may also be transmitted as latitude, longitude pairs as defined below under "Point Phenomena." Lightning is

from the National Lightning Detection Network™ (NLDN), which only reports cloud-ground strokes; it does not include inner cloud and cloud-to-cloud lightning. A caveat must be displayed with NLDN data to differentiate this product from those that contain other lightning strokes, such as from on-board storm detection equipment.

2.12 Type 1 Lightning Strike Image Encoding Scheme (pixel level)

Assigned Product ID # 101.

In this scheme lightning strike locations are marked at appropriate pixels within the image. Pixel values represent the age of the lightning strike. It is the avionics display system's responsibility to represent the lightning strike location and indicate lightning strike age. In this scheme lightning strike locations are marked

The following assumptions apply to this encoding scheme:

- It is unlikely that 2 or more strikes have occurred within the same pixel within the time window mentioned.
- Network latency decreases the value of reporting lightning more recently than 5 minutes.
- File might be a high spatial resolution (regional) data set.
- No intensity information is encoded (The display processing may integrate spatially or temporally to indicate intensity).
- Lightning proximity to flight plan can be solved graphically and therefore the latitude and longitude of each strike does not need to be transmitted.
- Time indicated is referenced to product generation. Display to pilot may include data link latency.
- Ground service provider may make a determination of missing data based on low confidence values within a region.

Table 2.12-1 Type 1 Lightning Strike Image

Code	Represents	Hex
0	No lightning strike	0x00
1	lightning strike within the last 5 minutes	0x01
2	lightning strike within the last 15 minutes	0x02
3	missing or low-confidence data within this region	0x03

2.13 Type 2 Lightning Strike Image Encoding Scheme (grid element level)

Assigned Product ID # 102.

In this scheme, lightning strike regions are marked at appropriate grid elements within the data set. Grid element values represent the age of the lightning strike and/or the number of lightning strikes within a time interval. It is the user's responsibility to represent the lightning strike location and indicate lightning strike age and frequency.

The following assumptions apply to this encoding scheme:

- File might contain a low-resolution regional or national dataset.
- Two (2) or more strikes have occurred within the same pixel domain in the time window specified. Intensity information is encoded.
- Network latency decreases the value of reporting lightning more often than within a 5-minute window.
- Time is referenced to product generation. On-board display may indicate additional data link latency.

Table 2.13-1 Type 2 Lightning Strike Image

Code	Represents	Hex
0	No lightning strike	0x00
1	Lightning strike within the last 5 minutes	0x01
2	2 ≤ # strikes <5 within the last 5 minutes	0x02
3	1 ≤ # strikes <5 from 5 to 15 minutes ago	0x03
4	1 ≤ # strikes from 15 to 30 minutes ago	0x04
5	5 ≤ # strikes within the last 5 minutes	0x05
6	5 ≤ # strikes 5 to 15 minutes ago	0x06
7	missing or low-confidence data for this region	0x07

2.14 Point Phenomena

Assigned Product ID # 151.

The point phenomena message may be used to express the distribution of weather phenomena such as lightning strikes that are highly localized in space and time. These messages describe a collection of such localized events integrated over a specified time period. The following assumptions are associated with this product:

- There can be up to 32 objects in a message, with up to 32 points in each object.
- Integration times can range up to one hour.
- Sequence numbers range up to 16.

Table 2.14-1 Point Phenomena

```
VectorPointObject SEQUENCE SIZE (1..32) OF VectorPoint

VectorPoint ::= SEQUENCE
{
sequenceNumber INTEGER (0..15),
ObjectType,
integrationTime INTEGER (1..60),  -- time in minutes
 SEQUENCE SIZE (1..32) OF PointObject
}

ObjectType ::= ENUMERATED
{
lightning (0),
reserved (3)     -- reserve space for up to 3 more types
}

PointObject ::= SEQUENCE
{
--note: angles expressed in hundredths of a degree
--pointLatitude and pointLongitude are defined like
--Latitude_hundredths and Longitude_hundredths
pointLatitude INTEGER (-9000..9000),
pointLongitude INTEGER (-18000..18000)
}
```

2.15 Surface Conditions/Winter Precipitation Graphic

Assigned Product ID # 201.

Surface conditions/winter precipitation graphics are transmitted in image format without a base map. Optionally they may be compressed using any appropriate scheme identified in Section D.2.2 in RTCA DO-267A. They contain data and annotation pixels. The data values consist of precipitation echo intensities with flags to indicate whether the precipitation is liquid, frozen, or in the crossover region between liquid and frozen. Surface conditions/winter precipitation graphics are regional and national. There are two types of annotations that may be included in a graphic: site status indicators, and missing severe weather boxes.

2.15.1 Site status indicators (optional)

In addition to precipitation intensities, Surface conditions/winter precipitation images may contain information about the status of each radar site. There are currently two status indicators that are used: 'present' and 'absent.' A site that is 'present' may be denoted in the image with a single pixel near the site's location with code 17. A site that is 'absent' may be denoted in the image with a single pixel near the site's location with code 16. It will be up to the end user's software to place a warning marker or 'ok' symbol to indicate the status of the radar site.

2.15.2 Missing severe weather box (optional)

An indicator of an area of missing severe weather may be included in the image. This area is known as a 'warning box.' It suggests that there are echoes of significant intensity missing from the image. The location of the missing echoes may be indicated with a color box. The border of the box (code 18) will be transmitted as 1 pixel in width, although it may be displayed with different thickness. The interior or the box (code 19) replaces all other pixel data.

Note: For color encoding, see Table 3-2, Section 3.8.2 in RTCA DO-267A.

Table 2.15-1 Winter Precipitation Table

Code	Represents		Hex
0	Radar data level 0	dBZ<20	0x00
1	Radar data level 1	20≤ dBZ < 30	0x01
2	Radar data level 2	30 ≤ dBZ < 40	0x02
3	Radar data level 3	40 ≤ dBZ	0x03
4	Mixed or unknown precip level 1	5 ≤ dBZ	0x04
5	Frozen precip level 1	5 ≤ dBZ	0x05
6	Missing – no data available		0x06
7	Reserved		0x07

There are several assumptions or conditions regarding this weather product:

- "Mixed" actually indicates a degree of uncertainty as to whether the precipitation in that area is frozen or not.
  - It is difficult to assign hazard levels to the mixed and frozen precipitation areas, since the nature of the precipitation in these areas is uncertain.
  - Mixed and frozen precipitation areas should be indicators to the pilot that he should seek more information (perhaps by calling a Flight Service Station).
- Present/absent site indicators are moved to the upper nibble of the byte to make them easy to remove. Rather than duplicate the present/absent site indicators, the user avionics may have to interpolate to fill in the pixel that is the site indicator.
- Because there is so much uncertainty in the interpretation of the mixed and frozen precipitation areas, they are assigned fewer bits than the liquid precipitation.

2.16 Surface Weather Systems

Assigned Product ID # 202.

This product can describe fronts, troughs, ridges, etc. Fronts and other line objects are described by sequences of vertices representing line segments. The direction of movement of the front can be deduced by the location of the PointObject, which is behind the direction of movement of the front. In other words, the barbs indicating direction of spread of the front should face away from the side of the line nearest the PointObject. This product assumes a maximum of 16 line objects in a message and up to 32 points in a line.

Table 2.16-1 Surface Weather Systems

```
SurfaceObservation ::= SEQUENCE
{
ExpirationTime,
SEQUENCE SIZE (1..16) OF LineObject
}

ExpirationTime ::= SEQUENCE
{
dayOfMonth INTEGER (1..31),
hourOfDay INTEGER (1..24)
}

LineObject ::= SEQUENCE
{
sequenceNumber INTEGER (0..15),
ObjectType,
-- note: angles expressed in hundredths of degrees
sourceLatitude INTEGER (-9000..9000),
sourceLongitude INTEGER (-18000..18000),
 SEQUENCE SIZE (1..32) OF PointObject
}

ObjectType ::= ENUMERATED
{
coldFront (0),
warmFront (1),
stationaryFront (2),
occludedFront (3),
trough (4),
ridge (5),
squallline (6),
reserved (7)   -- allow for two more types
}

PointObject ::= SEQUENCE
{
--note: angles expressed in hundredths of a degree
--PointObject indicates origin of front, i.e., barbs on front depiction should point
-- away from PointObject
pointLatitude INTEGER (-9000..9000), --like Latitude_hundredths
pointLongitude INTEGER (-18000..18000) –like Longitude_hundredths
}
```

2.17 Graphical AIRMETs, SIGMETs

Assigned Product ID # 254.

Graphical AIRMET products consist of the following three subtypes: Icing AIRMET graphics, Turbulence AIRMET graphics, and IFR AIRMET graphics. Graphical SIGMET products consist of SIGMET graphics and Convective SIGMET graphics. Graphical AIRMET and SIGMET products are transmitted in two formats: bitmaps without a base map; and vector format. The bitmap and vector encoding schemes are described in the following sections. Bitmap graphics are geographically referenced using a method described in Section D.2.3 in RTCA DO-267A. AIRMET and SIGMET vector graphics have internal latitude longitude pairs.

Graphical AIRMET and SIGMET files may be one of three forms:

- Individual graphical AIRMETs or SIGMETs in/near the service volume
- Collected graphical AIRMETs/SIGMETS in/near the service volume
- National map of graphical AIRMETs/SIGMETs

2.17.1 Graphical AIRMET, SIGMET Bitmap Encoding Scheme

In this scheme, hazard watch boxes are represented by polygons in the bitmap. The polygons may be filled or unfilled. A bitmap product may contain one or more polygons. Each polygon has a label associated with it containing an indication of the hazard type, severity, and/or a watch box ID (polygon ID). Polygons representing the same hazard within a bitmap are encoded with the same code values (e.g., several areas of icing); they are indistinguishable in the bitmap. Polygons representing different hazards within a bitmap are encoded with different code values (e.g., IFR and Mountain Obscuration). Up to three different types of hazards can be encoded in a single bitmap product. Each product includes a legend stating the valid outlook period for the product. In addition to the bitmap data, the bitmap products contain two fields: one indicating the product type (e.g., Icing AIRMET or Convective SIGMET) and one indicating the product generation time. The bitmap-encoding scheme is described in Table 2.17-1.

Table 2.17-1 Graphical AIRMETs, SIGMETs Bitmap Encoding Scheme

Code	Represents	Hex
0	Outside the hazard polygon	0x00
1	Product legend	0x01
2	Polygon 1 Outline: Label (Hazard type, altitude, etc.) Optional filled area	0x02
3	Polygon 2 (used as required) Outline: Label (Hazard type, altitude, etc.) Optional filled area	0x03
4	Polygon 3 (used as required) Outline: Label (Hazard type, altitude, etc.) Optional filled area	0x04

Note: Polygon 1 codes are repeated as necessary to define multiple watch boxes representing the same hazard. Polygon 2 codes are used as necessary to define one or more watch boxes representing a different hazard than Polygon 1. Polygon 3 codes are used as necessary to define one or more watch boxes representing a different hazard than Polygon 1 and 2.

2.18 Type 4 CONUS NEXRAD Precipitation Image – Global Block Representation

Assigned Product ID # 64.

2.18.1 Definition

This description provides the format for encoding a conterminous (CONUS) NEXRAD graphic product using the Global Block Representation format described in Section D.2.3.5 of RTCA DO-267A (FIS-B MASPS). The description further defines the 2 spare bits in the first byte of the Block Reference Indicator to enable multiple image resolutions. This two-bit field will be referred to as the Bin Scale Factor.

2.18.2 Assumptions

The receiving system can assume that when this product is received from multiple ground stations offering overlapping coverage, the areas of overlap will be assured to register and can be simply merged on the cockpit display. Each broadcasting ground station will typically broadcast product covering subset/region of the total image. Depending on the value of the Bin Scale Factor, the resolution of the product image will be different and need to be accommodated by the receiving application. .

2.18.3 APDU Format

2.18.3.1 APDU Header

The format of the APDU header used for this product is shown in the Figure below. It follows the APDU Header Format as outlined in Appendix D of RTCA DO-267A with none of the optional fields used for this product; specifically, no Product Descriptor options and no APDU segmentation are used.

The last four zeros show the pad that is required to round out the APDU header to end on a byte boundary. The time field encoded in the APDU header is the time of product creation.

← APDU Header (48 bits) →																																
FIS-B APDU ID (16 bits)	Product Descriptor (14 bits)																Header Time (13 bits)													Pad (4 bits)			
	Af	Gf	PF	Product ID (11 bits)											Sf	T opt	Hours (5 bits) *(See Note 3)*					Minutes (6 bits) *(See Note 3)*										
(See Note 1)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0													0	0	0	0

Transmission order →

Notes:

1) The FIS-B APDU-ID is not transmitted in the FAA (FIS-B) network

2) While this product employs the minimal APDU header format shown above, avionics designed for operation on the FAA's network should not preclude the ability to parse ADPUs with any of the optional fields invoked. This will ensure any future products that may employ these optional fields can be processed.

3) The Hours and Minutes fields each have the MSB as the leftmost bit and the LSB as the rightmost bit.

2.18.3.2 Payload

The Global Block Representation can represent image data at multiple resolutions. This is useful for NEXRAD images in particular because it allows larger scale images to be encoded with lower resolutions and regional images to have higher resolutions. This approach is both consistent with the intended use of the information by the pilot and the cockpit display presentation constraints

that exist (i.e., viewing larger geographic areas reduce the ratio of display pixels per unit area). The following Block Reference Indicator format supersedes the Figure D-3 in RTCA DO-267A.

Bin Scale Factor: This indicates the relative scale factor for the image represented by the encoding. The possible values of this field are:

Bit Number		Usage Label	Meaning
5	4		
0	0	High Resolution	Base encoding; each bin 1 min (lat), 1.5 min (lon) 0-60 deg latitude or 3 min (lon) 60-90 deg latitude
0	1	Medium, Resolution	5X encoding; each bin 5 min (lat), 7.5 min (lon) 0-60 deg latitude or 15 min (lon) 60-90 deg latitude
1	0	Low Resolution	9X encoding; each bin 9 min (lat), 13.5 min (lon) 0-60 deg latitude or 27 min (lon) 60-90 deg latitude
1	1		Reserved

The Global Block Representation geo references individual "bins" of the NEXRAD image to latitude and longitude rather than on a projection requiring a point of tangency. The encoded intensity levels for the individual "bins" map into "dBZ" reflectivity levels as shown in the table below.

Intensity Encoding of NEXRAD Precipitation Image

Intensity Encoded Value	dBz Reflectivity Range	Weather Condition	ATC Terminology
0	No Data		
1	$5 \leq dBz < 20$		
2	$20 \leq dBz < 30$	VIP 1	"Light"
3	$30 \leq dBz < 40$	VIP 2	"Moderate"
4	$40 \leq dBz < 45$	VIP 3	"Heavy"
5	$45 \leq dBz < 50$	VIP 4	"Heavy"
6	$50 \leq dBz < 55$	VIP 5	"Extreme"
7	$55 \leq dBz$	VIP 6	"Extreme"

Notes:

3) *The color rendering on cockpit displays of the Intensity Encoded Values 2(two) through 7 (seven) should follow the Color Philosophy for the associated Weather Condition as described in Section 3.8.2 (Table 3-2) of RTCA DO-267A (FIS-B MASPS).*
4) *The Intensity Encoded Value 0 (zero) means no reflectivity data was received. This will enable the avionics to provide an explicit indication to the pilot where NEXRAD is unavailable.*
5) *The Intensity Encoded Value 1 (one) is considered Background and should be color rendered accordingly.*
6) *ATC terminology in accordance with FAA Information for Operators dated 4/7/07 and revised controller terminology provided in the Aeronautical Information Manual, revised 3/15/07.*